Aug. 9, 1949. L. WILSON ET AL 2,478,732

COMBUSTION TUBE HEATING APPARATUS

Filed April 1, 1948 2 Sheets-Sheet 1

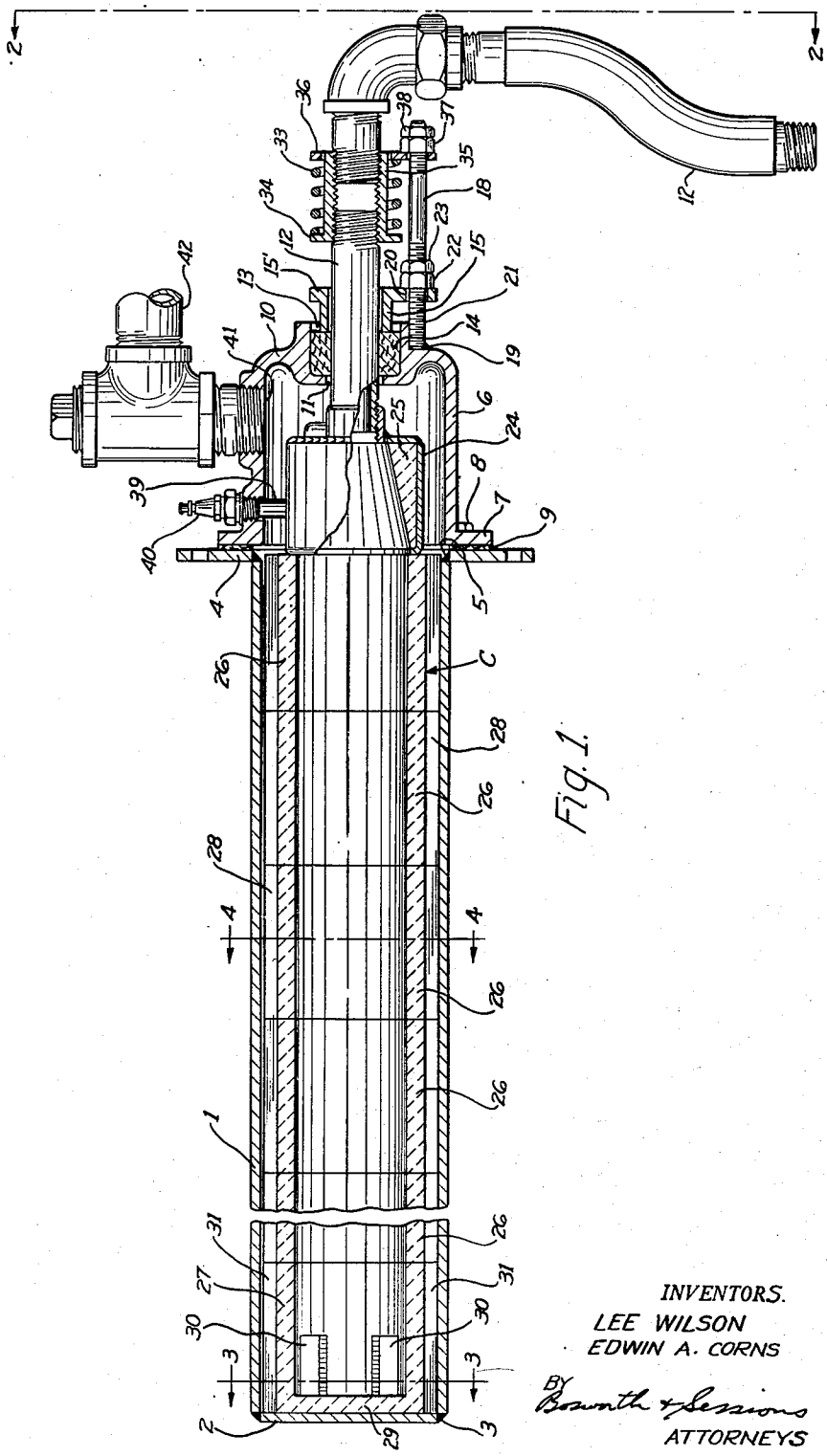

Fig. 1.

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Fig. 2.

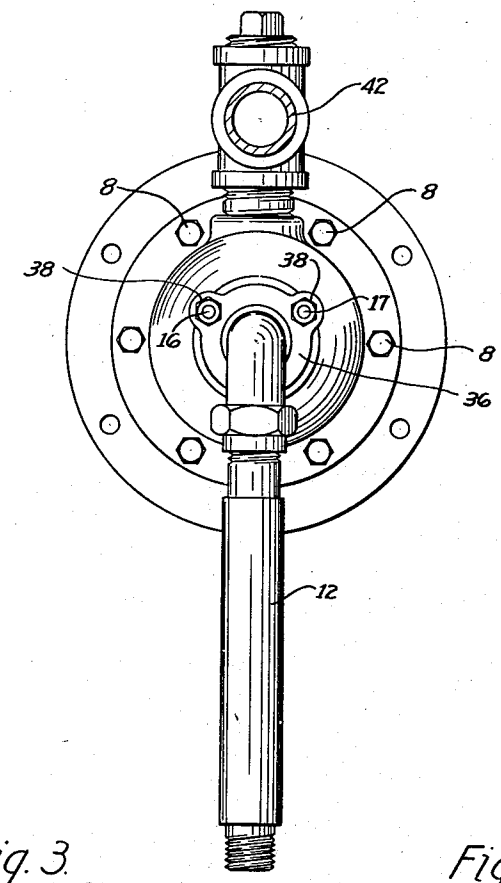


Fig. 3.

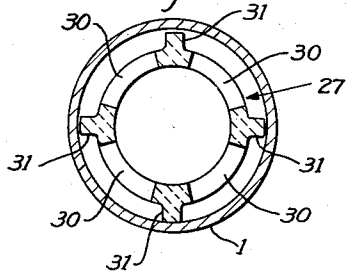
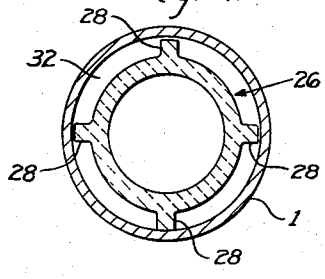


Fig. 4.



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UNITED STATES PATENT OFFICE

2,478,732

COMBUSTION TUBE HEATING APPARATUS

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5 Claims. (Cl. 126—360)

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This invention relates to heating apparatus and more particularly to improvements in self-contained heater units which are especially suitable for either radiant or immersion heating purposes and in which a combustible mixture of liquid or gaseous fuels may be employed.

Radiant tube type heaters in which fuel is burned within an elongated tube of high temperature resisting alloy have successfully been employed for various purposes such as supplying heat in bell type annealing furnaces, etc. In one form of this type of apparatus a combustible mixture is discharged into the inlet end of a straight or somewhat curved tube, burned within the tube, and exhausted from the other end of the tube at a point spaced from the inlet end. It has also been proposed to use tubular heater structures in which a return bent tube is employed whereby the products of combustion are discharged at or adjacent the combustible mixture inlet end of the tube. In both of these types of heaters difficulty has been experienced in securing uniform heat distribution throughout the length of the heater tube and, in installing the first mentioned type of tube, a floating connection or expansion joint must usually be provided between one of the tube end portions and the wall of the furnace, or other structure with which it is employed, in order to take care of expansion and contraction.

It is an object of the present invention to provide heating apparatus, of the type in which a combustible mixture is burned within a tubular structure, in which the contraction and expansion problem noted above is eliminated and whereby the temperature of the outside of the tube may be maintained at a more nearly constant value throughout the length of the tube than in previous tubular heaters with which we are familiar.

Other objects of our invention include: the provision of a tubular heater unit in which the metal parts of the heater are protected against extremely high temperatures whereby the life of the heater is greatly increased; the provision of a tubular heater which may be readily installed in a furnace or other structure without expansion joints or the like and which requires only a single opening through the structure wall; the provision of a tubular heater having a refractory combustion chamber which is completely enclosed and adequately protected; the provision of a tubular heater which may readily be made up in units of any desired length; and the provision of a rugged, efficient heater of the type described

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which may be economically manufactured and easily installed in various types of heating apparatus.

The above and other objects of our invention will appear from the following description of one embodiment thereof, reference being had to the accompanying drawings in which:

Figure 1 is a vertical longitudinal cross-sectional view through our improved tubular heater unit.

Figure 2 is an end elevation of the apparatus shown in Figure 1, taken substantially on line 2—2 of Figure 1.

Figure 3 is a transverse cross-sectional view taken substantially on line 3—3 of Figure 1.

Figure 4 is a transverse cross-sectional view taken substantially on line 4—4 of Figure 1.

As illustrated, our heating apparatus comprises an outer metal cover tube or shell 1, preferably of high temperature resistant alloy and closed at one end by an end plate 2 which is preferably secured to the tube 1 as by welding indicated at 3. At the opposite end of tube 1 from plate 2 is a mounting flange 4 which is also preferably welded to the tube 1 as seen at 5. The generally cup-shaped end cap 6 is formed with an outwardly projecting flange 7 at its open end. This flange 7 is secured to the mounting flange 4 by circumferentially spaced bolts 8 and a leakproof joint is insured by a suitable gasket 9 between the flanges 4 and 7.

The closed end portion 10 of end cap 6 is apertured at 11 to accommodate the combustible mixture supply pipe 12 and is recessed at 13 to receive packing material 14 whereby a leakproof connection is maintained between the end cap 6 and the fuel supply pipe 12.

To maintain the proper compression on the packing 14 a collar 15 is slidably supported on the circumferentially spaced studs 16, 17, and 18. As is best seen in Figure 1 these studs 18 are secured, as by welding at 19, to the end cap 6 and pass through properly spaced holes 20 in the flange portion 15' of collar 15. The studs 16, 17, and 18 are threaded adjacent their inner ends, as indicated at 21 in Figure 1, to accommodate the adjusting nuts 22 and lock nuts 23. From the above description it will be understood that by properly adjusting the nuts 22 on the three studs 16, 17, and 18 the pressure on the packing 14 can be regulated to secure the proper seal while permitting longitudinal sliding of the supply pipe 12 relative to the end cap 6 to accommodate for expansion and contraction of the parts in operation.

The inner end of supply pipe 12 carries a flared burner or end section 24 which preferably is formed with an outer metal shell and a refractory inner lining 25. The open end of burner 24 abuts and forms an inner end portion for the inner refractory combustion tube or chamber C which is made up of a plurality of identical sections 26 and an outer or closed end section 27. As will appear from Figures 1 and 4, each of the sections 26 comprises a refractory tube having outwardly projecting integrally formed spacing lugs or flanges 28 extending from its outer surface and uniformly spaced around the circumference of the tube. Although the spacing lugs or flanges 28 are illustrated as extending the full length of each tubular section 26 it will be understood that the lugs needs not be continuous in length. The illustrated arrangement facilitates manufacture however as it permits the sections 26 to be readily extruded or molded from suitable refractory material. The outer end section 27 of combustion tube or chamber C is formed with an integral end wall 29 and with a plurality of circumferentially spaced discharge ports or outlets 30.

Flanges or lugs 31, similar to the flanges or lugs 28 on sections 26, are formed on the outer surface of end section 27 and, as is best seen in Figure 1, one end section 27 and a number of tubular sections 26 are assembled together and disposed within the outer metal cover tube 1 to form a combustion tube or chamber C of the desired length. Although the flanges 28 of each section 26 and the flanges 31 of end section 27 are illustrated as disposed in axial alignment it will be understood that such alignment of these flanges is not essential to the proper operation of the apparatus as the major function of these flanges is to support the combustion tube C concentrically within the outer metal cover tube 1 so that an annular chamber 32 is provided between the combustion tube and outer cover. It will also be understood that in some instances it might be desirable to form the entire combustion tube C as an integral unit instead of in sections as has been described.

Combustion tube C is maintained in position within the cover tube 1 with its end portion 29 engaging the end plate 2 of outer cover 1 by the engagement of the open end of burner 24 with the open end of the combustion tube C. In order to maintain the desired engagement between these parts, while permitting relative movement between the inner combustion chamber, burner, and fuel feed pipe assembly and the outer cover portion or shell of the heater unit due to expansion or contraction of the parts in operation, a spring 33 is provided. One end of this spring 33 is seated against the flange 34 of a coupling 35 in pipe 12 and the opposite end seats against a plate member 36 slidably supported on the studs 16, 17, and 18. The outer ends of these studs are threaded to accommodate adjusting nuts 37 and lock nuts 38 and it will be seen from Figure 1 that by tightening down on the nuts 37 the pressure exerted by spring 33 on flange 34 may be increased with a corresponding increase in the pressure exerted by the open end of burner 24 on the open end of combustion tube C. The described arrangement provides a resilient means for urging the combustion tube C longitudinally of the outer cover tube 1 to maintain the sections 26 and 27 which make up the tube C in closely abutting relation to each other and to maintain the end wall 29 of the end section 27 in engagement with the end wall 2 of the outer cover 1. This resilient connection, as has previously been noted, permits the slight relative axial movement between the inner and outer tube structures which necessarily occurs in operation due to the different co-efficients of expansion of the metal of the outer tube 1 and the refractory material of which combustion tube C is made.

In order to ignite the combustible mixture which is supplied through the supply pipe 12 a pipe 39 extends from the interior of burner 24 to the wall of end cap 6 and a spark plug 40 of any suitable form is mounted in the end cap 6 at the outer end of pipe 39. To remove the products of combustion from our heater unit an exhaust port 41 is formed in the side wall of end cap 6 and may be connected to an exhaust pipe 42 of any suitable form.

In the operation of the above described apparatus a combustible mixture, such as gas and air or atomized oil and air, is directed through the pipe 12 into the burner section 24 where it is ignited by a spark from the spark plug 40. The fuel then burns within the refractory tube C and burned and/or unburned gases pass out through the discharge ports or outlets 30 into the annular chamber 32 between the outer metal cover 1 and the combustion tube C and then back over the outer surface of combustion tube C into the interior of the end cap 6 and out through the exhaust port 41 and exhaust pipe 42. By properly adjusting the combustible mixture and the pressure with which this mixture is supplied, the length of the flame in the heater and the location of the area of greatest flame temperature may be controlled in such a manner that the outer surface of tube 1 may be maintained at a substantially uniform temperature throughout its length. The inner refractory tube C protects the metal parts of the structure from direct flame impingement and extremely high temperatures. Heat is transferred from the inner refractory tube to the outer metal tube 1 by radiation across the annular chamber 32 and directly from contact with the hot gases and/or flame in the annular chamber 32, it being understood that in some instances the fuel may not be entirely burned before it passes through the discharge outlets 30 into the annular chamber 32 and that combustion will continue in a portion of this chamber.

Although we have illustrated and described one embodiment of our invention in considerable detail it will be understood that variations and modifications may be made in the form, proportions, and arrangement of the parts to accommodate different operating conditions and requirements. We do not therefore wish to be limited to the specific apparatus herein shown and described but claim as our invention all embodiments thereof coming within the scope of the appended claims.

We claim:

1. Heating apparatus of the type described comprising an inner refractory combustion tube, an outer metal cover tube enclosing said refractory combustion tube, means for supporting said combustion tube in concentric spaced relation to said outer cover tube, a combustible mixture supply pipe extending through one end portion of said cover tube into the adjacent end of said refractory combustion tube, said combustion tube having a discharge outlet at its opposite end, said cover tube having an exhaust port at the end thereof through which said supply pipe extends, and resilient means for urging said supply pipe

and combustion tube longitudinally of said cover tube to maintain said opposite end of said refractory tube in engagement with the corresponding end of said outer tube while permitting relative longitudinal expansion and contraction therebetween.

2. Heating apparatus of the type described comprising an inner refractory combustion tube, an outer metal cover tube enclosing said refractory combustion tube, circumferentially spaced integral lugs on the outside of said combustion tube for supporting same in concentric spaced relation to said outer cover tube, a combustible mixture supply pipe extending through one end portion of said cover tube into the adjacent end of said refractory combustion tube, said combustion tube having a discharge outlet at its opposite end, said cover tube having an exhaust port at the end thereof through which said supply pipe extends, and resilient means for urging said supply pipe and combustion tube longitudinally of said cover tube to maintain said opposite end of said refractory tube in engagement with the corresponding end of said outer tube while permitting relative longitudinal expansion and contraction therebetween.

3. Heating apparatus of the type described comprising a tubular outer shell of heat resistant metal, said shell being closed at one end and having a fuel pipe aperture at its opposite end, a fuel pipe extending through said aperture, a burner supported by said fuel pipe within said outer shell, an inner tubular refractory combustion chamber having a closed end and an open end, spaced lugs on the outside of said chamber, said refractory chamber being disposed within said shell with its closed end engaging the closed end of said outer shell and being held in concentric spaced relation to said shell by said lugs, said burner being positioned in said shell to discharge directly into the open end of said refractory chamber, and means for maintaining said burner in sealing engagement with said refractory chamber, said refractory chamber having an outlet aperture adjacent said closed end thereof, and said outer shell having an exhaust outlet aperture adjacent said fuel pipe aperture.

4. Heating apparatus of the type described including an outer tubular metal shell closed at one end and having spaced apertures at its opposite end, a combustible mixture inlet pipe extending through one of said apertures, sealing means between said inlet pipe and said outer tubular member, the other of said apertures forming an exhaust outlet for said outer tubular member, an inner refractory tubular combustion

chamber within said outer tubular shell, said combustion chamber being open at one end and having an end wall at its opposite end adjacent said closed end of said outer shell, integral radially spaced lugs on the outer surface of said refractory tubular combustion chamber for maintaining said combustion chamber concentrically disposed within said outer shell, and means for establishing a substantially fluid-tight connection between said inlet pipe and said open end of said inner refractory chamber, said inner refractory chamber having an outlet port adjacent its closed end for discharging gases into the space between said outer shell and said inner combustion chamber.

5. Heating apparatus of the type described including an outer tubular metal shell closed at one end and having spaced apertures at its opposite end, a combustible mixture inlet pipe extending through one of said apertures, sealing means between said inlet pipe and said outer tubular member, the other of said apertures forming an exhaust outlet for said outer tubular member, an inner refractory tubular combustion chamber within said outer tubular shell, said combustion chamber being open at one end and having an end wall at its opposite end adjacent said closed end of said outer shell, integral radially spaced lugs on the outer surface of said refractory tubular combustion chamber for maintaining said combustion chamber concentrically disposed within said outer shell, and resilient means for establishing a substantially fluid-tight connection between said inlet pipe and said open end of said inner refractory chamber, said inner refractory chamber having an outlet port adjacent its closed end for discharging gases into the space between said outer shell and said inner combustion chamber.

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